UNIVERSITY OF PENNSYLVANIA

A PSYCHOPHYSICAL STUDY OF VISUAL GESTALTEN

WINSLOW N. HALLETT

A THESIS

IN PSYCHOLOGY

PRESENTED TO THE FACULTY OF THE GRADUATE SCHOOL IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

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A PSYCHOPHYSICAL STUDY OF VISUAL GESTALTEN

By WINSLOW N. HALLETT, University of Pennsylvania

There has been relatively little psychophysical work done from the point of view of Gestalt psychology. The configurationists approach the problems of relational judgments quite differently from the psychophysicians.[1] The application of the methods of psychophysics to the problems of Gestalt may prove difficult, but there appears to be no *a priori* reason why an attempt should not be made.

The present paper marks an attempt to apply the constant method to one of the outstanding problems of Gestalt psychology, *i.e.* to the study of visual *Gestalten.*

The particular problem that we have undertaken is to discover whether a change in the configurational relationship would noticeably affect the thresholds for the judgment of the separation of two visually presented bars. In one case the judgment was to be made within a spontaneous dominant configuration and in the other it was to be made between two such spontaneous dominant configurations which apparently were in opposition to the particular configuration required for the judgment. The configurational membership was determined by the color of the bars, red and blue being used in two arrangements.

METHOD

Apparatus. Fourteen comparison-cards and one standard card were successively presented by means of a Whipple Disk Tachistoscope for an exposure-time of 75σ. This duration was adequate for a clear impression but too brief for exploratory eye movements.[2] Except for the first few hours the complete experiment was conducted in a dark room.

The 14 Comparison-Cards were divided into two series (A and B) of 7 cards each. The Standard Card was common for the two series. The cards were made of heavy white cardboard, 180 mm. wide and 100 mm. high, on which were pasted vertical bars 4 mm. wide and 50 mm. high.

The Standard Card contained two black parallel bars with a separation of 9 mm. The comparison-cards contained four parallel vertical bars, the separation between the two outer pairs of bars remained constant at 9 mm., while the separation between the two middle bars varied. The various separations of the middle bars were the same for Series A and B: 7½, 8, 8½, 9, 9½, 10, and 10½ mm.

* Accepted for publication April 6, 1932. This study was suggested and directed by Professor S. W. Fernberger.

[1] H. Helson, The psychology of gestalt, this JOURNAL, 37, 1926, 37.

[2] G. M. Whipple, *Manual of Mental and Physical Tests,* 1910, 227.

Series A and B differed only in the pattern formed by the color of the bars. Series A contained two red and two blue bars, the red to the left and the blue to the right. Series B contained three red bars and one blue bar, the blue being to the extreme right. The judgments required were of the relative separation of the two central bars. In Series A the judgments were between the inner bars of the two color pairs while in Series B the judgments were between the two center bars of the red group. In Series A the distances to be judged lay between two spontaneous configurations, while in Series B they lay within a spontaneous configuration formed by the color of the bars.

Procedure. *O* sat in a comfortable chair 7 ft. in front of the tachistoscope. The chair was of a height to bring his eyes on a level with the exposure-field. In order to escape the undesired effects of fatigue, *O* was permitted to rest whenever he desired. Whether he had availed himself of this privilege or not, a 5-min. rest period was given him at about the middle of every experimental hour.

The cards of the two series (A and B) were intermixed, and presented haphazardly. In order to minimize the influence of the serial arrangement, 10 different haphazard orders were employed during the course of the study. But one time order was used in presenting the cards. The standard was always presented first, and then the variable. The comparisons were made as rapidly as possible. After some practice *E* was able to give the *O*s 14 comparisons on an average, in a 5-min. work period —approximately 1 every 20 sec.

The *O*s were permitted to write down their casual introspections at the end of every experimental hour.

Observers. The *O*s,[3] 5 in number, where Dr. Stanley F. Cooper (*C*), Dr. John F. Humes (*H*), Dr. Francis W. Irwin (*I*), members of the Departmental Staff, and Mr. Wendell R. Carlson (*K*), and Mr. Charles C. Limburg (*L*), graduate students. All possessed normal or normally adjusted vision. Three of them (*C, H,* and *I*) were acquainted with tachistoscopic procedure while for 2 (*K* and *L*) it was new. All were unacquainted with the details of the experiment except those given in the instructions and apparent in the procedure. Each served for a period of about an hour, on 2 days a week, for 15 weeks, extending from February to June, 1931.

Every *O* gave a total of 3,500 judgments: 250 on each of the 14 comparison-cards —25 for each of the 10 haphazard orders.

Instructions. The following instructions were read at the beginning of each experimental session.

I am going to show you a number of cards. First I shall show you a standard card of two bars, then a comparison-card of four bars, then another standard card and another comparison-card and so on. I want you in each case to pay careful attention to the standard card and then give me your judgment for the following comparison-card. The standard card may vary as well as the comparison-cards. I want you to judge whether the central bars of the comparison-card are the same distance apart as the bars of the standard or whether the distance apart is greater or less. After each comparison-card you will give me your judgment, merely saying the words 'less,' 'equal,' or 'greater.' Be sure in each case to pay careful attention to the standard card so that you may give a true comparison judgment. Before presenting a standard card I will say the words 'standard' and 'now' with a short pause between. Before presenting a comparison-card I will say the words 'ready' and 'now' with a short

[3] I wish to express my thanks to the *O*s for their assistance and coöperation.

pause between. I want your judgments on the comparison-cards to be immediate. Just say 'less,' 'equal,' or 'greater.'

Results

For every *O*, 25 judgments were obtained on the 14 comparison stimuli for each of the 10 haphazard orders of presentation. Consecutive fractions were paired for purposes of calculation. From these 5 combined fractions, measures were computed separately for Series A and B in accordance with the $\Phi(\gamma)$ hypothesis making use of Urban's tables.[4]

These computed measures are shown in Tables I to X, all of which are similar. There are 2 tables for every *O*. The odd numbered tables show results for Series A, the even for Series B. In the first column of each of the 10 tables is shown the combined consecutive fractions for which the meas-

TABLE I

C's Results in Series A

Order	h_1	h_2	S_1	S_2	I.U.	P.S.E.
1 & 2	0.83	1.19	8.46	9.41	0.95	9.02
3 & 4	0.91	1.02	8.45	9.55	1.11	9.03
5 & 6	1.07	1.17	8.17	9.30	1.13	8.76
7 & 8	0.82	1.09	8.16	9.33	1.17	8.83
9 & 10	1.20	1.18	8.28	9.27	0.99	8.77
Av.	0.97	1.13	8.30	9.37	1.07	8.88

TABLE II

C's Results in Series B

Order	h_1	h_2	S_1	S_2	I.U.	P.S.E.
1 & 2	0.80	0.89	8.59	9.45	0.86	9.04
3 & 4	0.81	1.15	8.46	9.43	0.97	9.03
5 & 6	0.88	1.13	8.18	9.26	1.09	8.79
7 & 8	1.34	1.18	8.07	9.30	1.23	8.65
9 & 10	1.02	1.14	8.23	9.36	1.13	8.83
Av.	0.97	1.10	8.31	9.36	1.06	8.87

TABLE III

H's Results in Series A

Order	h_1	h_2	S_1	S_2	I.U.	P.S.E.
1 & 2	0.57	0.55	8.66	9.23	0.56	8.94
3 & 4	0.71	0.69	8.76	9.02	0.26	8.89
5 & 6	0.65	0.62	8.93	9.15	0.22	9.04
7 & 8	0.52	0.52	8.89	9.25	0.36	9.07
9 & 10	0.77	0.78	8.92	9.07	0.15	8.99
Av.	0.64	0.63	8.83	9.14	0.31	8.99

[4] See S. W. Fernberger, A simplification of the practice of the method of constant stimuli, this Journal 25, 1914, 121-130. Also G. J. Rich, A checking table for the method of constant stimuli, *ibid.*, 29, 1918, 120-121.

TABLE IV

H's Results in Series B

Order	h_1	h_2	S_1	S_2	I.U.	P.S.E.
1 & 2	0.50	0.54	8.54	9.17	0.63	8.86
3 & 4	0.67	0.63	8.64	8.94	0.31	8.78
5 & 6	0.60	0.59	8.76	8.98	0.22	8.87
7 & 8	0.53	0.50	8.63	9.01	0.39	8.81
9 & 10	0.68	0.75	8.91	9.13	0.23	9.03
Av.	0.60	0.60	8.70	9.05	0.36	8.87

TABLE V

I's Results in Series A

Order	h_1	h_2	S_1	S_2	I.U.	P.S.E.
1 & 2	1.25	1.28	8.56	9.36	0.80	8.97
3 & 4	1.46	0.88	8.56	9.15	0.59	8.78
5 & 6	1.87	1.19	8.51	9.36	0.85	8.84
7 & 8	1.53	0.91	8.59	9.42	0.84	8.90
9 & 10	1.87	1.47	8.69	9.46	0.77	9.03
Av.	1.60	1.15	8.58	9.35	0.77	8.90

TABLE VI

I's Results in Series B

Order	h_1	h_2	S_1	S_2	I.U.	P.S.E.
1 & 2	1.11	1.30	8.51	9.18	0.67	8.87
3 & 4	1.44	1.17	8.47	9.10	0.62	8.75
5 & 6	2.14	1.31	8.43	9.33	0.90	8.77
7 & 8	1.06	1.13	8.61	9.43	0.82	9.03
9 & 10	1.39	1.56	8.72	9.55	0.83	9.16
Av.	1.43	1.29	8.55	9.32	0.77	8.92

TABLE VII

K's Results in Series A

Order	h_1	h_2	S_1	S_2	I.U.	P.S.E.
1 & 2	1.19	1.20	8.53	9.56	1.03	9.05
3 & 4	1.60	1.05	8.64	9.80	1.16	9.10
5 & 6	1.29	1.09	8.70	10.02	1.31	9.30
7 & 8	1.08	1.31	8.81	10.16	1.35	9.55
9 & 10	1.35	1.43	8.70	9.87	1.17	9.30
Av.	1.30	1.22	8.68	9.88	1.20	9.26

TABLE VIII

K's Results in Series B

Order	h_1	h_2	S_1	S_2	I.U.	P.S.E.
1 & 2	0.94	1.82	8.45	9.39	0.94	9.07
3 & 4	1.35	1.60	8.45	9.63	1.18	9.09
5 & 6	1.69	1.54	8.56	9.86	1.29	9.18
7 & 8	1.22	1.91	8.55	9.92	1.37	9.39
9 & 10	1.30	1.13	8.68	9.99	1.31	9.29
Av.	1.30	1.60	8.54	9.76	1.22	9.20

TABLE IX

L's Results in Series A

Order	h_1	h_2	S_1	S_2	I.U.	P.S.E.
1 & 2	1.17	0.94	8.27	9.83	1.56	8.97
3 & 4	1.25	1.15	8.33	9.88	1.54	9.07
5 & 6	0.84	1.11	8.26	10.17	1.90	9.34
7 & 8	0.90	1.08	8.04	10.14	2.10	9.18
9 & 10	1.31	0.86	8.07	9.90	1.83	8.80
Av.	1.09	1.03	8.19	9.98	1.79	9.07

TABLE X

L's Results in Series B

Order	h_1	h_2	S_1	S_2	I.U.	P.S.E.
1 & 2	1.01	1.06	8.25	9.67	1.43	8.98
3 & 4	1.27	1.15	8.23	9.61	1.38	8.88
5 & 6	1.34	1.20	8.10	9.77	1.67	8.89
7 & 8	1.05	1.16	7.92	9.88	1.96	8.95
9 & 10	1.33	1.07	8.17	9.84	1.68	8.91
Av.	1.20	1.13	8.13	9.75	1.62	8.92

ures were calculated. In the second and third columns are shown the Coefficients of Precision for the 'Less' and 'Greater' judgments, h_1 and h_2 respectively. In the fourth and fifth columns are shown the thresholds for the 'Less' and 'Greater' judgments, S_1 and S_2 respectively. The sixth column shows the values of the Interval of Uncertainty, and the seventh column shows the Point of Subjective Equality.[5] The average for each of the measures is shown in the bottom row of the table.

In Figs. 1 to 5 are shown straight line graphs of the judgments of every *O* for the entire experiment obtained by combining the judgments for all 10 fractions. The curves for the 'Less,' 'Equal,' and 'Greater' judgments are readily distinguishable. It will be noted that the curves are relatively of the normal $\Phi(\gamma)$ type. The values for Series A are connected by continuous lines, while those for Series B are connected by broken lines. It will be noted that there is little difference between the results of the two series. The curves for *C, H,* and *I* practically coincide in the two series, and those for *K* and *L* are very like.

The Intervals of Uncertainty are the most crucial values for the purposes of our experiment as they are the chief measures of the accuracy of judgment. Let us consider them in more detail. Table XI gives these values with their Probable Errors for all the *O*s for each series, together with their dif-

[5] For an explanation of these measures see S. W. Fernberger, On the relations of the methods of just perceptible differences and constant stimuli, *Psychol. Monog.*, 14, 1913, (no. 61), 29-49.

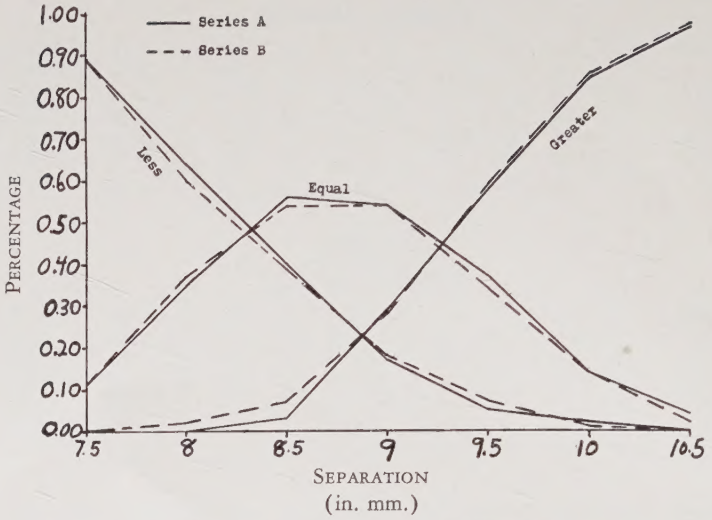

FIG. 1. CURVES SHOWING *C*'S RESULTS

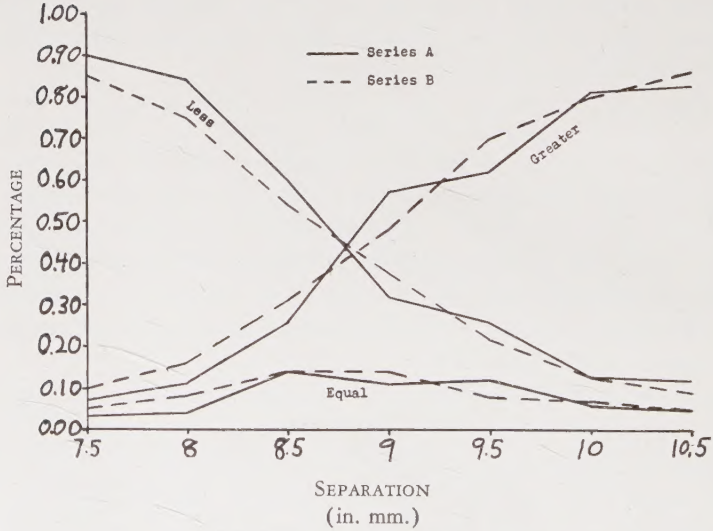

FIG. 2. CURVES SHOWING *H*'S RESULTS

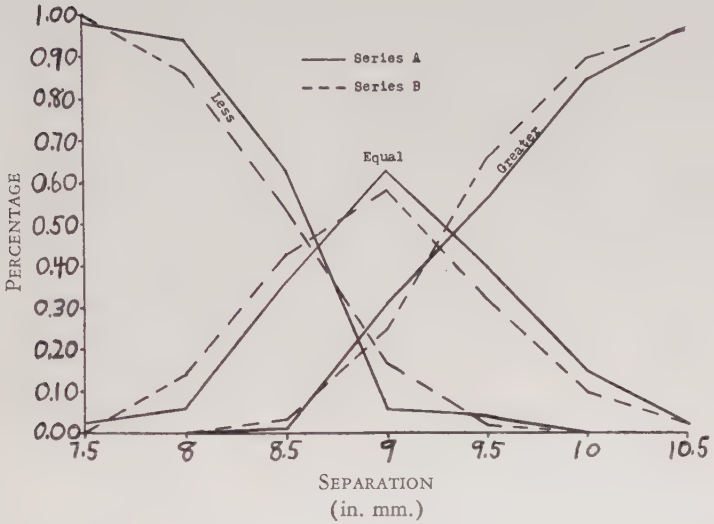

FIG. 3. CURVES SHOWING *I*'S RESULTS

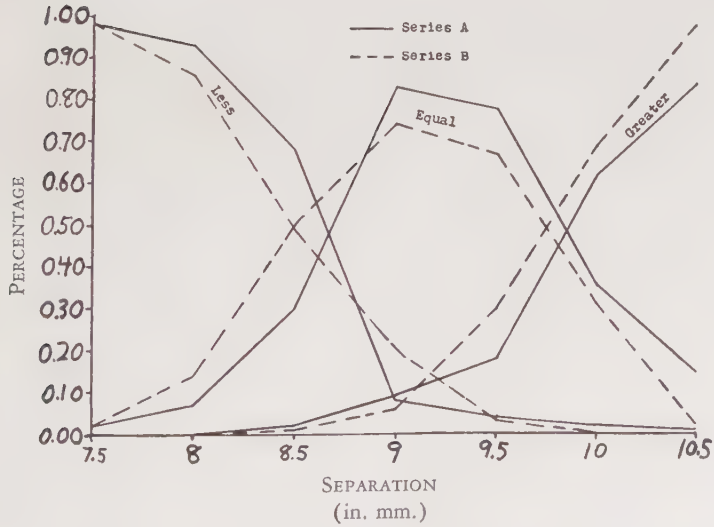

FIG. 4. CURVES SHOWING *K*'S RESULTS

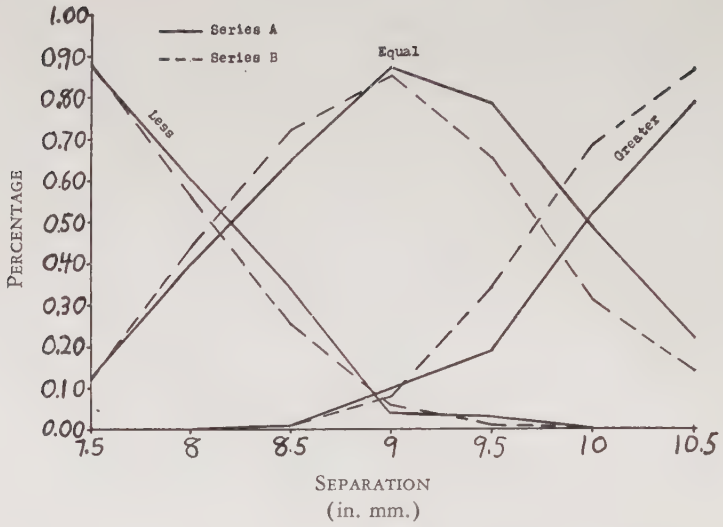

FIG. 5. CURVES SHOWING *L*'S RESULTS

ference and an index of the significance of that difference.[6] One of the *O*'s, (*I*), shows no difference between the intervals of uncertainty, and two of them (*C* and *L*) show a difference in one direction, and two (*H* and *K*) show a difference in the opposite direction. The differences are all small and the indexes of reliability are likewise small ranging from 0.1031 for *C* to 0.7485 for *L*. These values, even *L*'s the largest, are too low to indicate any real significance. Such difference as we found must be regarded, therefore, as being due to chance.

Not only do the size and direction of the average interval of uncertainty vary among the different *O*s, but they also vary in the results of the in-

TABLE XI

COMPARISON OF THE AVERAGE INTERVALS OF UNCERTAINTY FOR EVERY *O*

	Interval of Uncertainty					
	Series A		Series B		Diff.	Significance of
O	Av.	P.E.	Av.	P.E.	(A–B)	Differences
K	1.20	.0384	1.22	.0513	−0.02	.1667
C	1.07	.0283	1.06	.0432	+0.01	.1031
H	0.31	.0479	0.36	.0506	−0.05	.3699
I	0.77	—	0.77	—	0.00	—
L	1.79	.0715	1.62	.0701	+0.17	.7485

[6] For the determination of this index see S. W. Fernberger, Interdependence of judgments within the series for the method of constant stimuli, *J. Exper. Psychol.*, 3, 1920, 141-142.

dividual *O*s. As shown in Tables I-X, where the data are fractionated for every *O* into 5 equal parts, the intervals of certainty for a given *O* are sometimes larger for Series A and sometimes for Series B. For *L* alone do the differences between comparable fractions all lie in the same direction, *i.e.* toward Series A. *H* is the next most consistent. In 4 of the 5 fractionations, Series B is the larger, and in the fifth fraction the two series are equal. The data of the other 3 *O*s, however, show considerable fluctuation. The intervals of uncertainty are larger in Series A for 3, 2, and 2 of the 5 fractionations for *C, I,* and *K* respectively.

From a consideration of all these facts it is evident that any conclusion as to a definite and statistically significant difference between the Intervals of Uncertainty for the two configurations would be unwarranted. This means that the two configurational arrangements in Series A and B exerted no differential effect on the ability to judge differences in the two cases under our experimental conditions.

The Points of Subjective Equality for Series A and B as shown in Tables I to X show no uniformity in their relation to actual equality. There appears to be no consistent time error, nor is the approximation to actual equality consistently closer for one series than for the other.

From a consideration of the size of the Coefficients of Precision for Series A and B, as indicated in Tables I to X, we again find no consistent difference. Also, there is no uniform tendency for the Coefficients of Precision to become larger or for the Intervals of Uncertainty to become smaller in the later fractions as compared with the earlier fractions. This would be expected if improvement due to progressive practice took place in the accuracy of judgments.

Our findings in this experiment have indicated no differential effect for the two configurations used in Series A and B. Moreover, there does not seem to have been any added effort required to judge one series as compared with the other. At least the occasional recorded introspections do not reveal such a condition. The one configurational arrangement seems to have given as accurate results and presented no more difficulty of any sort than the other.

These findings are not in accordance with the results expected at the outset of the experiment from other studies of the influence of configurations upon thresholds. We had expected that the configurational nature of Series B would facilitate judgments and that of Series A would tend to impair the accuracy of judgments. Series B, as we have pointed out, involved judgments within a dominant spontaneous configuration, while Series A involved judgments between two dominant spontaneous configurations. The organi-

zation of the two central bars required for judgments under the conditions of this experiment should be favored by the former configuration and directly opposed by the latter configuration.

Conclusions

From this experiment we are led to conclude one of three things: (1) either configurational membership exerts no influence upon the thresholds for the judgment of the separation of two objects visually presented; (2) or the conditions of our experiment were inadequate to detect such influence actually present; (3) or our interpretation of the nature of our stimuli was incorrect due to the inadequacy of color alone to materially effect configurational organization.

Summary

(1) Thresholds were obtained by the method of constant stimuli for the judgment of the separation of bars in two different visual Gestalten, one of which demanded judgments within a dominant spontaneous configuration and the other of which demanded judgments between two dominant spontaneous configurations. The configurations were determined by the color of the component bars, red and blue being used in two different arrangements.

(2) A treatment of the judgments of the two configurational arrangements gave similar results. No differential effect was apparent for the two configurational arrangements for the Intervals of Uncertainty, the Points of Subjective Equality, or the Coefficients of Precision. The results for the two configurational arrangements showed no consistent or significant differences.